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PHYSICOCHEMICAL CHARACTERSTICS (AB-DTPA EXTRACTABLE P AND K) OF SOIL UNDER DIFFERENT FIELD CONDITIONS

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Abstract

A field survey was conducted in District Abbottabad, Pakistan to evaluate soil physico-chemical properties during the year 2023. Twenty representative soil samples were collected at depth 0-15 cm locations and recorded their coordinates through Global Positioning System (GPS). These samples were analyzed for soil pH, EC, texture, AB-DTPA extractable P, K and lime content. Results indicated that soil texture was mostly sandy loam and silty loam. The pH values of soil samples under investigations varied from 7.50 to 8.52. Electrical conductivity ranged from 0.02 to 0.24 dS m^{-1}. Lime content of soil ranged from 2 to 21.75 % showing that 50% of the samples were highly calcareous in nature, while 45% of the samples were moderately calcareous. The AB-DTPA extractable P content in soil under investigations ranged from 0.95 to 45.80 mg kg^{-1}. The P content was Low in 30 %, medium in 10% and high in 60% soil samples. The AB-DTPA extractable K content of soil ranged from 34.8 to 188.8 mg kg^{-1} and was low in 40%, medium in 30% and high in 30% soil samples. Results suggested that soil under investigations could be improved by the addition of Farmyard Manure (FYM), with chemical Fertilizers and proper soil management practices for sustainable crop production.

Keywords: FYM, pH, EC, texture, AB-DTPA extractable P, K and lime content.

Introduction

It is a well-recognized fact that nation's economic and social well-being is completely dependent upon its natural resources and if a nation is to continue as a prosperous and powerful unit, it must have a complete and an accurate inventory of all his major resources. Amongst all the natural resources, the real wealth and the greatest heritage of a nation lie in his soil resources. The wise use and preservation of the soil resources of a country can transform a poor society into a prosperous one (Atkinson and Hamilton, 2003).

Soil fertility is declining day by day due to intensive cropping in order to fulfill the needs of rapidly growing population. To maintain the optimum fertility status of soil, application of different fertilizers is recommended by the agricultural scientists. The types and amounts of fertilizers to be applied depend on the crop to be grown and nutrient supply power of the soil. The application rate, amount and type of nutrients as per crop requirements and conservation of soil fertility and productivity potentials are based on many soil physico-chemical and biological properties. These properties along with monitoring the fertility status are playing the key role in sustainable production from the area.

For maximum production and good quality, it is necessary to supply nutrients in a balance amounts, because inadequate supply of nutrients causes serious disorder in vegetables, fruits and cereals. These nutrients may be classified into macro and micronutrients. Macronutrients include N, P and K required in larger amount, while micronutrients include Fe, Cu, Zn, B and Mn required in smaller amount. Macronutrients along with micronutrients are need for various physiological functions of vegetable, fruits and cereals. Nitrogen increases growth and development of living tissue of plants. Phosphorus is necessary for cell division, stimulates roots development, seed and fruit development. Potassium increases size of grains or seeds and improves the quality of fruit. In addition, it is also involved in activation of about 60 enzymes (Tisdale et al. 1985).

About 21 samples from 0-15 cm surface soil were collected from Tehsil Abbottabad of district Abbottabad. These soils were analyzed for soil lime content, pH, EC, soil texture, P and K status.

Materials and methods

The survey type study was conducted in the tehsil Abbottabad of district Abbottabad Khyber Pakhtunkhwa. The district lies at the Latitude of 34.1304° N and Longitude 73.1822° E. District Abbottabad is the capital city of Hazara Division of eastern Khyber Pakhtunkhwa, Pakistan. It is the 40th largest city in Pakistan and 6th largest in the province KP. It is about 120 km (75 mi) north of Islamabad and Rawalpindi, and 150 km (93 mi) east of Peshawar, at an altitude of 1,256 m (4,121 ft).

Soil samples from 0-15 cm surface layer were collected from 20 different locations of Tehsil Abbottabd during the month of January 2023. During the survey, general observations on field were also recorded. Moreover, where possible, relevant information from concerned farmers were collected during soil sampling from each field. The location of samples along with farmer name is given in the following table.

Table 1 Location of the soil samples collected from district Abbottabad.

S.No	Locations	Farmers Name
1	Kakol	Dildar Ahmad
2	Nawan Sher Janubi	Muhammad Tayyab
3	Sir Bhanna	Muhammad Miskeen
4	Biran Gali	Gulzar Awan
5	Bagh	Muhammad Sadiq
6	Dahamtore	Ashraf
7	Mir pur	Riaz Ahmad
8	Phal kot	Muhammad Arshad
9	Banda Pir khan	Muhammad Sajjid
10	Bandi Dhundan	Qari Shamsudin
11	Namal	Haji Ahmad Khan
12	Bagnotar	Zaheerudin
13	Namli Mera	Jhangir Khan
14	Banda Qazi	Falak Nawaz
15	Jhangi	Aziz Ullah
16	Pawa	Sher Khan
17	Sheikhul Bandi	M. Yaqoob

18	Boi	Bashir Ahmad
19	Salhad	Ghulam Mustafa
20	Kokmang	Sarwar Awan

Soil Sampling

Soil samples from each field were collected from the depth of 0-15cm. Soil sample were collected randomly from five different spots to make the composite sample. Soil auger was used for sampling purposes. Soil samples were kept in plastic bags and labeled for further processing.

Soil Analysis

Soil samples were brought to the lab and sieved carefully and then analyzed for physiochemical characteristics and extractable P and K.

Soil pH

Soil pH was determined in soil-water suspension of 1:5. For this purpose 10 g soil was shaken with 50 ml distilled water for 30 minutes. After filtering, the extract was read by pH meter (InoLab pH meter) as described by US Salinity Staff (1954). The pH meter was first calibrated against buffers of pH 7.0 and 9.0 before running the soil samples.

Soil EC

The soil suspension made for soil pH analysis was used for this purpose. The EC in filtrate was determined though EC meter (WTW, Germany). Before the soil sample analysis the machine was calibrated against 0.1 N KCl solution.

Soil texture

Soil texture was determined by the Bouyoucos hydrometer method as reported by Gee and Bauder (1986). The 50 g air-dried soil was dispersed with 5 mL 10% sodium metahexaphosphate solution in a mechanical dispersion machine for 5 minutes. After transfer of the suspension to a 1L Bouyoucos cylinder, filling the cylinder with distilled water to 1L mark. After thorough mixing inserted a hydrometer in the suspension and took the hydrometer reading after 40 sec for silt+clay and after 2hr for

clay. Also note temperature of the suspension with each hydrometer reading and made necessary corrections in hydrometer readings. Percent silt and clay were calculated for hydrometer reading while percent sand was calculated by difference. Percent sand, silt and clay were used to determine soil texture class on the USDA soil textural triangle (Bouyoucos method, 1962).

Mathematically:

$$\%\ Clay\ = \frac{\text{Corrected hydrometer reading}}{\text{Weight of a Soil}} \times 100$$

This formula was also used for % silt+clay in soil.

Soil Potassium Content

10 g of soil samples was taken in a conical flask then 20 mL of AB-DTPA solution was added to it, and shaken for 15 minutes after shaking filtered with Whatman filter paper No.42 filter paper. 1 ml sample was taken from each filtrate in a volumetric flask of 25 mL, then 5 mL of ascorbic acid was added and make the volume up to the mark. Placed the sample for 15 minutes for Color development and then potassium was determined by Flame Photometer "Sherwood" model. Photometry 410 calibrated with standards.

Soil Phosphorus Content

The AB-DTPA extractable P content was determined in the soil by Soltanspour and Sehwab (1997) method. The 10 g soil sample was taken in a flask with 20 mL of AB-DTPA and shaken gently on Reciprocating shaken for 15 minutes. Suspension was filtered through Whattman filter paper NO.42. Phosphorus was determined by Ammonium molybdate color reagent measuring on 880 nm wavelength using Spectrophotometer.

Lime Content

5 g of soil samples was weighed in flask and treated with 50 mL of 0.5N HCI. The flask was covered with a watch glass and the solution was placed on hot plate for 10

minutes, then cooled, filtered and washed all the soil with water. Add few drops of phenolphthalein indicator and titrated against 0.25N NaOH solution till appearance of pink color by the method as described by Richards (1954).

Mathematically:

$$\% \, Lime = \frac{[(\text{mL of HCL} \times \text{N of HCL}) - (\text{mL of NaOH} \times \text{N of NaOH})] \times 0.05}{\text{Weight of a Soil}} \times 100$$

Results and discussion

The samples collected from various locations of district Abbottabad during the month of September 2020 and were analyzed for physiochemical properties and fertility status of soils investigated in the Department of Soil and Environmental Science laboratory of The University of Agriculture Peshawar, KP.

Physical Properties

Physical properties of soil affect root growth and hence productivity of crops (Sadghtoor, 2008). It is governed by a number of factors which includes depth of soil, texture, organic matter etc., the relative proportion of various soils separate like sand, silt, clay, gravel and course fragment determine the soul textural class. Cohesion of these individual particles to form aggregates is called a soil structure. The proportion of each size group in a given soil cannot be altered and thus is considered a basic property of a soil.

Soil pH

Soil pH of Tehsil Abbottabad are presented in table 1. Table 1 showed that the pH values in the surface soil (0-15 cm) ranged from 7.50 to 8.52 in the Union Council of Tehsil Abbottabad. The maximum pH (8.52) was recorded at the Union Council Bandi Dhundan that was strongly alkaline closely followed by 8.49, 8.45 and 8.44 at Namal, Namli Mera and Kokmang respectively, while, as the minimum pH was recorded (7.50) at Bagh that was slightly alkaline. The mean value of pH of all the samples was (8.18). The results showed that the pH was greater than 7 and less than 9, So the Tehsil Abbottabad soil was

alkaline soil. Table 1 (a) showed that under investigation 75 % of soil sample lies in moderately alkaline range, whereas 25 % lies in slightly alkaline soil.

Similar results were obtained by Rashid et al., (2008). The soil of Peshawar valley are slightly to strongly calcareous with neutral to strongly alkaline reaction, having pH from 7.2 to 9.1 (Anon., 1973).

Table 1. Soil pH (1:5) values of surface soil (0-15 cm) collected from different areas in Tehsil Abbottabad of district Abbottabad.

S.No	Location	pH	S.No	Location	pH
1	Kakol	8.17	11	Namal	8.49
2	Nawan Sher Janubi	8.03	12	Bagnotar	8.30
3	Sir Bhanna	7.65	13	Namli Mera	8.45
4	Biran Gali	7.79	14	Banda Qazi	8.21
5	Bagh	7.50	15	Jhangi	8.31
6	Dahamtore	7.96	16	Pawa	8.41
7	Mir pur	8.32	17	Sheikhul Bandi	7.95
8	Phal kot	8.28	18	Boi	8.17
9	Banda Pir khan	8.23	19	Salhad	8.49
10	Bandi Dhundan	8.52	20	Kokmang	8.44
	Minimum value				**7.50**
	Maximum value				**8.52**
	Mean				**8.18**

Table 1(a). Classification of soil pH value ranges of studied Areas.

Range	Acidic/Alkalinity	No of sample	%age of total sample
<4.0	Very strongly acidic	…..	…..
4-5	Strongly acidic	…..	…..
5-6	Moderately acidic	…..	…..
6-7	Slightly acidic	…..	…..
7.0	Neutral	…..	…..
7-8	Slightly alkaline	5	25%
8-9	Moderately alkaline	15	75%
9-10	Strongly alkaline	…..	…..
10-11	Very strongly alkaline	…..	…..

Rashid and Ahmad (1994), Rashid *et al.*, (1994).

Soil EC

Electrical conductivity of soil in Tehsil Abbottabad are shown in table 2. Table 2 showed that the Electrical conductivity values in the surface soil (0-15 cm) ranged from 0.023 dS m^{-1} to 0.241 dS m^{-1} in the Union Council of Tehsil Abbottabad. The highest EC (0.241 dS m^{-1}) was recorded at the Union Council Biran gali closely followed by (0.205 dS m^{-1}) was recorded at Nawan Sher Janubi, while, as the minimum pH was recorded (0.023 dS m^{-1}) at Kokmang. The mean value of soil Electrical conductivity was (0.061 dS m^{-1}). The results showed that the EC of the soil in Abbottabad region is low. The low EC in soil shows good drainage system in the soils of the area. It can be concluded from the survey that the soils in the area had no sign of salinity and could be successfully used for a variety of agricultural crops and orchard cultivation (US Salinity Staff, 1954).

Soil Texture

Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. The particles that make up soil are categorized into three groups by size: sand, silt, and clay. Sand particles are the largest and clay particles the smallest. The relative percentages of sand, silt, and clay are what gives soil its texture.

Table 3 showed the soil texture of different soils of Abbottabad region. Soil texture refers to the size of individual soil particles. Soil Particles have different size depending on the kind of parent rocks and the degree of weathering. The particle size diameter ranges or

categorized as sand (0.05-2.0 mm), Silt (0.002-0.05 mm) and clay (<0.002 mm).The results showed that from 20 soil samples of Tehsil Abbottabad the texture of the soil was found sandy loam at kakol, Biran Gali, Dahamtore, Phal Kot, Banda Pir Khan, Bagnotore, Banda Qazi and Salhad. Silty loam also found in Nawa Sher Janubi, Bandi Dhundan, Naml, Namli Mera, Jhangi, Pawa, Sheikhul Bandi And Kokmang. Whereas, Bagh and Mir Pur soil texture was loamy sand. The soil texture classes of Tehsil Abbottabad area are 45% sandy loam, 45% are silt loam and 10% are loamy sand.

Table 2 Soil EC values of surface soil (0-15 cm) collected from different areas in Tehsil Abbottabad of district Abbottabad.

S.No	Location	E	S.No	Location	Ec
1	Kakol	0.091	11	Namal	0.032
2	Nawan Sher Janubi	0.205	12	Bagnotar	0.045
3	Sir Bhanna	0.058	13	Namli Mera	0.040
4	Biran Gali	0.241	14	Banda Qazi	0.038
5	Bagh	0.077	15	Jhangi	0.034
6	Dahamtore	0.060	16	Pawa	0.031
7	Mir pur	0.031	17	Sheikhul Bandi	0.035
8	Phal kot	0.046	18	Boi	0.030
9	Banda Pir khan	0.048	19	Salhad	0.028
10	Bandi Dhundan	0.044	20	Kokmang	0.023
	Minimum value				**0.023**
	Maximum value				**0.241**
	Mean				**0.061**

Table 2a. Guideline use for interpretation of soil Electrical Conductivity

Nature of Soil	EC (dS m^{-1})	ESP	SAR

Saline	≥4	<15	<15
Sodic	<4	≥15	≥15
Saline-Sodic	≥4	≥15	≥15
Normal Soil	<4	<15	<15

Table 3 Soil texture of soil (0-15 cm) collected from different areas in Tehsil Abbottabad of district Abbottabad (Give sand, silt and clay values in table

	Location	Sand	Silt	Clay	Textural Class
		---------- % ----------			
1	Kakol	54.6	42	3.4	Sandy loam
2	Nawan Sher Janubi	44.6	50	5.4	Silt loam
3	Sir Bhanna	58.6	38	3.4	Sandy loam
4	Biran Gali	60.6	36	3.4	Sandy loam
5	Bagh	80.6	14	5.4	Loamy sand
6	Dahamtore	76.6	16	7.4	Sandy loam
7	Mir pur	74.6	22	3.4	Loamy sand
8	Phal kot	60.6	34	5.4	Sandy loam
9	Banda Pir khan	58.6	38	3.4	Sandy loam
10	Bandi Dhundan	34.6	62	3.4	Silt loam
11	Namal	20.6	76	3.4	Silt loam
12	Bagnotar	58.6	38	3.4	Sandy loam
13	Namli Mera	40.6	54	5.4	Silt loam
14	Banda Qazi	50.6	46	3.4	Sandy loam
15	Jhangi	32.6	64	3.4	Silt loam
16	Pawa	42.6	54	3.4	Silt loam
17	Sheikhul Bandi	44.6	52	3.4	Silt loam
18	Boi	34.6	62	3.4	Silt loam
19	Salhad	52.6	44	3.4	Sandy loam
20	Kokmang	36,6	58	5.4	Silt loam

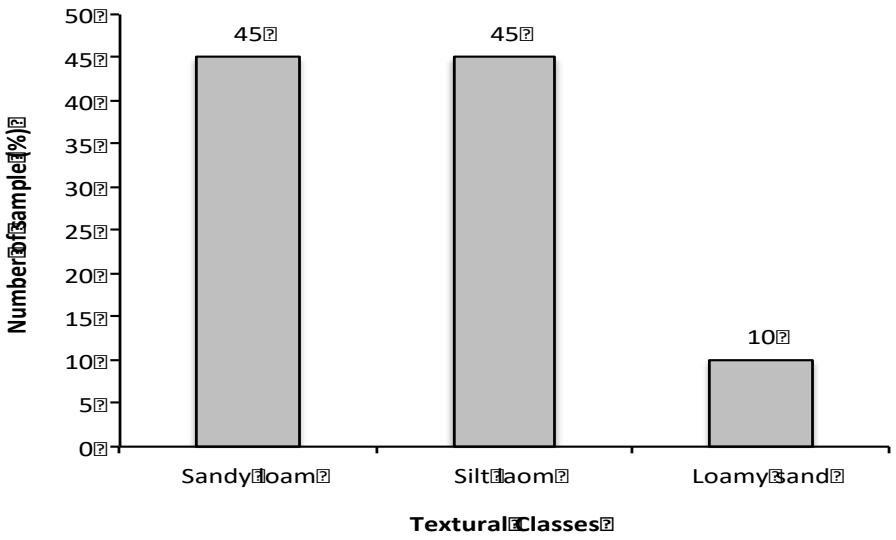

Fig. 1 Distribution of textural Classes is sampled area of District Abbottabad

AB-DTPA extractable potassium

The results of AB-DTPA extractable potassium (K) content of soils of Tehsils Abbottabad in surface (0-15 cm depth) soil are given in Table 4. The AB-DTPA extractable K ranged from 34.8 to 188.8 mg kg^{-1} with a mean value of 92.7 mg kg^{-1} in the study area suggesting that on overall mean value bases the K was marginal in the area. The maximum value of AB-DTPA extractable potassium (188.8 mg kg^{-1}) was recorded for Namli Mera closely followed by 174.6 and 167.2 mg kg^{-1} for the Tehsil Kakol and Dhamtore respectively, while the minimum values for AB-DTPA extractable potassium (34.8 mg kg^{-1}) was recorded. Soil analysis table 4(a) showed that 40% soil sample under investigation were in low range, 30% was in medium range and 30 % are in high range. The results findings of Rashid and Ahmad (1994) are like our findings.

AB-DTPA extractable phosphorus

Phosphorous play a key role in DNA synthesis, new cell formation and root development. The results of AB-DTPA extractable phosphorus (p) content of soils of Tehsils Abbottabad in surface (0-15 cm depth) soil are given in Table 5, Whereas classification criteria of AB-DTPA extractable phosphorus (P) mg kg^{-1} values into low medium and high range was noted in Table 5(a).

The results showed that the maximum value for AB-DTPA extractable phosphorus (45.80 mg kg^{-1}) was recorded for Bagh , closely followed by (45.31 mg kg^{-1}) Biran Gali, While as minimum value for AB-DTPA extractable phosphorus was recorded (0.95 mg kg^{-1}) for Salhad, closely followed by (0.98 mg kg^{-1}) for Kokmang. These results were similar to that of Rehman et al., (1993) and Rashid & Bhatti (2005).

Table 4 AB-DTPA extractable potassium (K) values of surface soil (0-15 cm) collected different areas in Tehsil Abbottabad of district Abbottabad.

S.No	**Location**	AB-DTPA K	**S.No**	**Location**	AB-DTPA K
		(mg kg^{-1})			(mg kg^{-1})
1	Kakol	174.6	11	Namal	85.2
2	Nawan Sher Janubi	45.2	12	Bagnotar	52.8
3	Sir Bhanna	34.8	13	Namli Mera	188.8
4	Biran Gali	47.2	14	Banda Qazi	38.6
5	Bagh	60.8	15	Jhangi	66.4
6	Dahamtore	167.2	16	Pawa	108.2
7	Mir pur	55.6	17	Sheikhul Bandi	123.8
8	Phal kot	147.4	18	Boi	73.2
9	Banda Pir khan	160.2	19	Salhad	55.6
10	Bandi Dhundan	108.6	20	Kokmang	59.8
	Minimum value				**34.8**
	Maximum value				**188.8**
	Mean				**92.7**

Table 4(a) Classification criteria of AB-DTPA extractable potassium (K) mg kg^{-1} values into low medium and high range.

Category	Range	No of samples	%age of samples
Low	< 60	8	40%
Medium	60-120	6	30%
High	>1 20	6	30%

Rashid and Ahmad (1994), Rashid *et al.*, (1994).

Table 5 AB-DTPA extractable phosphorus values of surface soil (0-15 cm) collected from different areas in Tehsil Abbottabad of district Abbottabad

S.No	Location	AB-DTPA P	S.No	Location	AB-DTPA P
		(mg kg^{-1})			**(mg kg^{-1})**
1	Kakol	21.54	11	Namal	2.00
2	Nawan Sher Janubi	43.39	12	Bagnotar	13.76
3	Sir Bhanna	25.11	13	Namli Mera	9.37
4	Biran Gali	45.31	14	Banda Qazi	23.55
5	Bagh	45.80	15	Jhangi	3.83
6	Dahamtore	19.91	16	Pawa	4.04
7	Mir pur	1.32	17	Sheikhul Bandi	1.75
8	Phal kot	9.24	18	Boi	1.03
9	Banda Pir khan	27.35	19	Salhad	0.95
10	Bandi Dhundan	8.70	20	Kokmang	0.98
	Minimum value				**0.95**
	Maximum value				**45.80**
	Mean				**15.44**

Table 5(a) Classification criteria of AB-DTPA extractable phosphorus (P) mg kg^{-1} values in to low medium and high range.

Category	Range	No of samples	%age of samples
Low	<3	6	30%
Medium	4-7	2	10%
High	>7	12	60%

Rashid and Ahmad (1994), Rashid *et al.,* (1994).

Soil Lime content

Data regarding soil lime content was presented in Table 6. Data revealed that lime contents of soil samples ranged from 2% to 21.75% with an average value of 13.55%. These results suggest that 50% of the soils are strongly calcareous in nature, 45% of soil are moderately calcareous and 5% are slightly calcareous (Table 6.a). Lime plays an important role in pH below 4.5. When the highly acidic soils are limed, it improved fine texture soil to less sticky and crumblier. It also provides favorable condition for root growth and movement of water in the soil. Further the availability of phosphates, molybdenum, the exchangeable calcium and magnesium also increase. Lime stimulates the microbial activity. In the soil calcium is derived from decomposition of rocks containing calcium such as lime stone. In high pH soil, the lime in form of calcium carbonates is fatal.

Table 6 Lime content of surface soil (0-15 cm) collected from different areas in Tehsil Abbottabad of district Abbottabad

S.No	Location	lime	S.No	Location	lime
		%			%
1	Kakol	17.50	11	Namal	19.5
2	Nawan Sher Janubi	7.25	12	Bagnotar	10.5
3	Sir Bhanna	6.25	13	Namli Mera	17
4	Biran Gali	19.50	14	Banda Qazi	16.75
5	Bagh	17.50	15	Jhangi	8.25
6	Dahamtore	15.25	16	Pawa	9.25
7	Mir pur	12.75	17	Sheikhul Bandi	8.50
8	Phal kot	12.50	18	Boi	2
9	Banda Pir khan	17.75	19	Salhad	15
10	Bandi Dhundan	16.25	20	Kokmang	21.75
	Minimum value				**2**
	Maximum value				**21.75**
	Mean				**13.55**

Table 6(a) Classification of soil samples based on lime content

Category	Range	No of samples	%age of samples
Low	<3.0 (slightly calc)	1	5%
Medium	3-15 (moderately calc.)	9	45%
High	>15.0 (strongly calc.)	10	50%

Bhatti (1997), Soltanpour (1985), Rashid and Ahmad (1994), Rashid *et al.*, (1994).

Summary, conclusion and recommendations

Summary

The proposed research work was conducted to assess the fertility status of soil samples collected from district Abbottabad. Total of 20 soil samples were collected very carefully from different location with GPS coordinates from a depth of 0-15 cm. Five different soil samples were collected within 10 m radius of the same point and made it a composite sample. All soil samples were properly packed, labeled and brought to the laboratory of Soil and Environmental Sciences Department, The University of Agriculture Peshawar. The soil samples were dried, clean from other debris including stone, non-degradable material etc and were ground. The ground samples were sieved and store for further analysis in the laboratories.

Results indicated that soil texture was mostly of sandy loam and silty loam classes. The pH values of soil samples under investigations varied from 7.50 to 8.52. Electrical conductivity ranged from 0.023 to 0.241dSm^{-1}. Lime content of soil ranged from 2 to 21.75% showing that 50% of the samples were highly calcareous in nature, while 45% of the samples were moderately calcareous. The AB-DTPA extractable P content in soil under investigations ranged from 0.95 to 45.80 mgkg^{-1}. The P content was Low in 30 %, medium in 10% and high in 60% soil samples. The AB-DTPA extractable K content of soil ranged from 34.8 to 188.8 mgkg^{-1} revealed that K content was low in 40%, medium in 30% and high in 30% soil samples. Results suggest that soil under investigations may be improved by the addition of Farm Yard Manure (FYM), with chemical Fertilizers and proper soil management practices for sustainable crop production in areas under investigations.

Conclusions

The following conclusions were drawn from the conducted research work.

1. Soil samples collected from the area under study were medium texture soil. 45% of soil samples were sandy loam, 45% were silt loam and 10% were loamy sand texture soil.

2. 50% of soil sample were strongly calcareous, 45% were moderately calcareous, while 5% sample were slightly calcareous.
3. The AB-DTPA extractable phosphorus content was low in 76 % sample, medium in 16 % sample and high in 8% sample.
4. The AB-DTPA extractable potassium content was adequate in 60%, medium in 10% and deficient in 30% of soil sample of the studied area of District Abbottabad.

Recommendations

The Following recommendations are formulated based on the findings of the conducted research work.

1. Organic fertilizers may be applied with chemical fertilizers to meet the deficiency of nutrients and improve the crops productivity.
2. Further investigations are needed to determine soil physical and chemical properties, soil fertility status and their correlation with yield on larger scale in different agrochemical zone of Pakistan.

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